2011

Adaptive Memory and Social Influences

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ADAPTIVE MEMORY AND SOCIAL INFLUENCES

by

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A thesis submitted to the Department of Psychology

in partial fulfillment of the requirements for the degree of

Master of Arts in General Psychology

UNIVERSITY OF NORTH FLORIDA

COLLEGE OF ARTS AND SCIENCES

July, 2011

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Dedication

First and foremost I give thanks to God. The accomplishments that follow are dedicated to his glory. I would also like to dedicate this thesis to my loving and supportive family. Thanks to my mother, Cheryl, my father, David, and my sister, Taylor.

Acknowledgement

I also thank my thesis advisor, Dr. Michael Toglia. His personality, helpfulness, and love for his students make him a joy to work with. His knowledge, experience, and skill make him one of a kind. Dr. Toglia's willingness to mentor regardless of the other constraints on his time is made all the more impressive by the fact that he is the chair of the department.

I would also like to thank my second reader, Dr. Christopher Leone. The speed at which he responds back, and the insight he has given has been vital. Dr. Leone not only demonstrates a fierce willingness to mentor. He does so while balancing his work as a dedicated professor and while running a productive lab. His assistance is greatly appreciated.

I would like to recognize Dr. Toglia's lab, specifically Bianca Navarrete and Mandy Zamore for their assistance in data collection. Finally, I would like to thank Natalie Hofmann, Alex Blandina, and Adam Wilde for their individual support and input, and Heather Pease, Anna Pittman, and Lee Gainey for their wealth of statistical knowledge.

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Abstract

Recently, cognitive psychologists have focused their research on the survival aspects of human memory, showing advantages for remembering information encoded for adaptive qualities. When participants rated words related to survival relevance (stranded in grasslands), Nairne et al. (2007) and others found survival processing's retention superior to many semantic encoding techniques, however, we questioned the global application of survival processing. In the present adaptive memory experiment we used the thematic word list paradigm pioneered by Deese, Rodeiger and McDermott, allowing us to measure false recall of critical items from sets of word lists. To investigate recall differences based on the material type encoded, we separated recalled material into two categories: survival and non-survival. Because arousal can influence memory performance, we extended research on adaptive memory to include social arousal induced by videotaping participants during study and recall tasks. Videotaping subjects has been shown to induce arousal levels similar to those when being observed, and may parallel arousal experienced in survival scenarios. Overall, recall was lower for survival processing. Survival-relevant information was more accurately remembered, and was not hindered by camera presence, unlike non-survival information. Additionally, false memories were higher under videotaped conditions. While our results did not support Nairne and colleagues, our findings may support the development of evolved brain mechanisms. The current findings are discussed with an emphasis on contemporary high arousal situations that may influence the activation of adaptive memories. We join a growing set of literature that questions the overall benefits of survival processing.

Keywords: cognition, memory, adaptive memory, evolution, survival processing, DRM, false memory, intrusions, word list, arousal, social facilitation, camera

Adaptive Memory and Social Influences

Albert Einstein is believed to have said “Memory is deceptive because it is colored by today's events.” This “quote” is an accurate example of but a single issue influencing human recollection. The benefits of memory, even with all its flaws, should not be underestimated. Situations previously experienced are remembered in some form, and therefore potentially accessible at a later time. This ability to remember allowed our ancestors to adjust their behavior, maximize productivity, and increase the likelihood of their survival. It has been argued that the human memory systems in place today have evolved to allow humans to remember and recall information as efficiently and effectively as possible (Klein, Cosmides, Tooby& Chance, 2002), and any errors may in fact at times be beneficial to an individual, a point we return to later. As a product of evolution the human brain may be particularly attuned to remembering in a survival context, specifically for survival relevant information (Howe & Derbish, 2010; Nairne & Pandeirada, 2008). This may be especially so for high arousal situations, as could often have been the case when these memory systems were developed.

The Cognitive Revolution

Behaviorism, beginning around 1920, monopolized much of experimental psychology until the 1950s. Most research mirrored that of Ivan Pavlov and Edward Thorndike, which focused on objectively observable and quantifiable responses to stimulus events. John Watson and other behaviorists argued that psychologists should avoid attempts to explain mental functioning, and rather focus on observable behavior (Mandler, 2007; Neisser, 1967).

As psychology’s focus began to shift in the mid 1950s away from Behaviorism, classic studies such as those by George Miller on short-term memory facilitated an already growing interest in cognition (Miller, 1956). With the field expanding, computers and technology of the day provided new approaches, including artificial intelligence, for studying cognition (Neisser, 1967). Based in part on these technologies, the modal model (Atkinson & Shiffrin, 1968) put forward not only a new framework for which to understand human memory, but also opened the floodgates for cognitive researchers to study the characteristics and functions of sensory memory, short-term memory, and long-term memory.

In this regard, evidence began to accumulate showing humans' ability to focus on information from the environment deemed relevant to survival (Sperling, 1960). Following perceptual processing, human memory had to allow one to focus on and work within the realms of a manageable amount of information (Miller, 1956), and to discard information quickly if one's energy was to be better spent elsewhere (Bower, 2000). It has been argued that the capacity limit of short-term memory, seven plus or minus two (Miller, 1956), is adaptive. Not only do these limits force one to focus on that which is most vital to survival by concentrating on a smaller set of information, it also increases one's ability to sense patterns and causation (Nairne, Thompson, & Pandeirada, 2007). Similar considerations should drive what information is transferred to long-term memory, such that more cognitive effort can then be focused on memories of greater importance.

Anderson and Schooler suggested that there is a cost associated with memory. This is seen both in the time dedicated to memory retrieval and encoding, and also metabolic expenditure while doing so (Anderson & Schooler, 2000). The gain received by being able to correctly recall is offset by these costs. It is argued that the cost of having memory void of error may outweigh any potential benefits. While there are no limits to the capacity of long-term memory, problems arise both with the accuracies of encoding and with the accuracy and ability to retrieve information for long-term memory (Brown & Craik, 2000). However distortions and even forgetting, while seen as negative, may actually be advantageous. Is it beneficial to be able to recall any past experience, if one must first sift through all unnecessary past experiences to access it? With potentially high costs associated with memory, survival relevant material should not only be readily available for retrieval, but also be as error free as possible.

Current theorists has suggested that most, if not all aspects of human memory, evolved to facilitate survival (Anderson & Schooler, 2000; Burns, Burns, & Hwang, 2011; Nairne et al., 2007). What may be considered a “flaw” or “limitation” of memory may in fact be a developed mechanism designed to help the individual optimize their time and resources. The human mind’s ability to remember, misremember, and forget, may be features of human cognition that evolved for perpetuation of the human species. Thus human memory may be adaptive in nature.

Adaptive Memory

Since its foundation in the late 1950s and early 1960s, the main focus of cognition has been that of understanding brain capabilities and limitations. Recently, researchers interested in the evolutionary development of the human mind have shifted their focus from “what” and “how” the brain accomplishes what it can, to “why” and “how” it has developed the mechanisms to do so (Anderson & Schooler, 2000).

Adaptive memory theorists believe our brain’s memory systems have evolved to function in their current state (Nairne et al., 2007). Early man’s brain evolved under the constraints of his environment, and therefore is best suited to act in an environment mimicking the conditions under which it developed. The human brain may have evolved to remember information most likely to facilitate the survival of the individual based on relevance to ancestral situational factors. It is believed that early humans came to best remember information relevant to their survival, such as locations of food and water, proper tool building skills, and how to best handle predators; in short they were probably best equipped to handle survival scenarios (Nairne et al., 2007). As with other mechanisms explained by the law of natural selection (i.e., bipedal movement, flight, or a giraffe's neck), advanced memory systems capable of processing, storing, and retrieving information evolved over time, with the "fittest" of the species procreating (Darwin, 1859). Individuals with the most efficient and effective memory systems in place to navigate and survive their environment were those most likely to genetically pass on this efficiency.

Instead of one general memory mechanism, the human brain is more likely composed of multiple specific mechanisms that evolved under particular environmental stressors to aid in differing survival situations (Soderstrom & Cleary, 2012). As evolution has shaped contemporary brain mechanisms to be primarily domain-specific, we selectively attend to and create memories encoded from past events. We may do this most reliably in a survival context (Nairne & Pandeirada, 2008). Thus it is believed there are domain specific modules that are capable of addressing specific tasks as sculpted by nature. While many of these mechanisms have evolved for functions related to issues affecting early man, their functionality is not limited to the specific domain for which it evolved (Nairne et al., 2007). These modules facilitate other situations faced by early man, as well as contemporary circumstances. Present-day man is able to use these domain-specific mechanisms for current memorial situations, though they evolved for another function. As Nairne et al. state in their 2007 article, "The proximate mechanisms that allow us to read and write could not have evolved for those ends, although reading and writing achieve many adaptive results." (p. 263). Though these different mechanisms evolved under specific constraints to address specific issues of their time, they can be applied to more current problems as well as global issues. Studies have shown while processing material for its relevance to survival in an ancestral context, such as Nairne’s classic grasslands scenario, leads to superior recall (Nairne et al., 2007) this memory task can be modified to include envionments and predators (in separate experiments) that could not have been present when these mechanism evolved. These envionments and predators (outer space and zombies, respectively) led to equal or better memory than Nairne’s origional Grassslands survival scenario (Soderstrom & Cleary, 2012).

The memory systems in place seem to have evolved to better remember certain information (Nairne et al., 2007). As a product of evolution, is seems our brains would be well-suited to remember information most closely related to our survival, such as a predator, food location, or mate (Nairne et al., 2007). The memory mechanisms in place did not evolve to simply allow one to remember the past, as that alone is minimally adaptive. There is greater adaptive value in the ability to reference the past and to more accurately predict what will happen in the future. “The fact that memory is fundamentally constructive rather than reproductive, often laced with relevant but “false” recollections provides prima facie evidence for this claim [that memory evolved to help predict the future, not remember the past] (Nairne & Pandeirada, 2008, p. 240).”

Survival Processing

With our brains seemingly attuned to these adaptive mechanisms, Nairne and his colleagues were interested in the benefits to memory, of applying a “survival” type of processing to memory. Nairne and colleagues randomly assigned participants to rate sets of unrelated words in one of three conditions. One group rated words on how relevant they would be to survival if the participant was stranded on grasslands of a foreign land using the following scenario:

In this task we would like you to imagine that you are stranded in the grasslands of a foreign land, without any basic survival materials. Over the next few months, you'll need to find steady supplies of food and water and protect yourself from predators. We are going to show you a list of words, and we would like you to rate how relevant each of these words would be for you in this survival situation. Some of the words may be relevant and others may not – it's up to you to decide.

Another group rated the relevance of words in relation to moving to a foreign land using the following scenario:

In this task we would like you to imagine that you are planning to move to a new home in a foreign land. Over the next few months, you'll need locate and purchase a new home and transport your belongings. We are going to show you a list of words, and we would like you to rate how relevant each of these words would be for you in accomplishing this task. Some of the words may be relevant and others may not – it's up to you to decide.

A third group rated the words on how the pleasantness of each word, as pleasantness ratings are a standard task for promoting a semantic analysis of verbal material (Einstein & Hunt, 1980). Participants rated each item using the following directions:

In this task we are going to show you a list of words, and we would like you to rate the pleasantness of each word. Some of the words may be pleasant and others may not – it's up to you to decide (Nairne et al., 2007).

The second and third groups served as control groups. However, all three groups engaged in a deep (semantic) level processing by making a rating judgment for each word (Craik & Tulving, 1975).

After a short distractor task, participants recalled as many words as they could remember. Survival processing led to the best retention (Nairne et al., 2007). These researchers also measured the number of intrusions (non-list words) that appeared in participants recall protocols. They found that subjects in the survival and moving conditions had an increased proclivity to recall words not included on the original lists. Overall, Nairne and his colleagues found that survival processing led to an increase in memory, while intrusion levels were similar to other semantic processing types, therefore demonstrating superiority to other types of processing (Nairne et al.. 2007). Nairne's further studies demonstrate survival processing's superiority to other contextually rich and self-relevant scenarios (Nairne, Pandeirada, & Thompson, 2008). Later studies by Nairne and his colleagues found incidental survival processing lead to even better memory than a general intentional memory task (Nairne et al., 2008). In their intentional memory task no specific processing was used (…*we are going to show you a list of words, and we would like you to try to remember those words for a future memory test)*. No studies were conducted using survival processing for intentional memory.

As Nairne's study and others that support his accuracy of memory findings (Kang, McDermott, & Cohen, 2008; Weinstein, Bugg, & Roediger, 2008) enlisted a surprise (incidental) memory task, it may be difficult to extrapolate his findings to memory as a whole. Intentional learning may rely on different mechanisms. Survival processing may increase memory when one is not explicitly trying to remember something, but as different memory modules may be used, this may not be the case when actively trying to retain information. Additionally, Nairne saw little difference for intrusions between survival processing and his other semantic tasks. As Nairne and his colleagues used non-thematic word lists, which typically produce low and inconsistent levels of false recall, differences in individual intrusion levels may have been difficult to detect among groups.

The Deese, Roediger, &McDermott (DRM) Paradigm

Word lists are commonly employed in a myriad of memory tasks. James Deese (1959) attempted to explain common intrusions he saw while conducting experiments involving free recall of word lists. Intrusions were especially prevalent when the word lists were of a thematic nature (all centered around a similar topic or theme). As a result, Deese was interested in discovering a technique that could predict these intrusions and demonstrate that a participant's semantic associations accounted for intrusion occurrence (Deese, 1959). He attempted to create lists that could reliably lead participants to produce specific intrusions and to predict their frequencies of doing so. One group of his participants listened to lists of twelve words centered on a thematic related, but omitted item. After hearing a list, participants recalled as many words as possible, often recalling the central thematic word. Another group of participants engaged in an association task, writing down the first word they could think of after reading each of list items. Deese compared these associations against the Minnesota norms using the Kent-Rosanoff Association (Russell & Jenkins, 1954) test and found similar results. Deese discovered that when participants studied lists that contained thematically-related words, all associated with a critical non-presented word (CNP) that was central to the theme, they tended to recall that word as an intrusion (Deese, 1959). For example, the words: *table, sit, legs, seat, couch, desk, recliner, sofa*, *wood*, *cushion,* and *swivel* all comprise one list. The list is centered on a thematic word (*chair*) that is not presented, though often recalled.

Henry Roediger and Kathleen McDermott revived this technique in 1995. Prior to the works of Deese, most studies investigating false memories used either narratives or recognition tasks. Narratives, such as Bartlett's classic "War of the Ghosts" were recalled with many thematically based errors (schematically-based errors, in his terminology), or false memories (Bartlett, 1932). While Deese was interested in why some lists were more likely to cause recall of the CNP (e.g., *chair*), Roediger and McDermott were interested in developing Deese's paradigm to reliably measure false memories (Roediger & McDermott, 1995). Their first experiment replicated Deese's methods. Roediger and McDermott's replication yielded similar false memory results as those in the initial 1959 Deese experiment, with participants recalling CNPs at a reliably high percentage (50%). and recognized them at even a higher rate (80%) in a second experiment described below, thus demonstrating the robustness of false memories across different lists.

In their second experiment, Roediger and McDermott were interested in expanding the paradigm by adding more lists and extending the length of the original lists from twelve to fifteen words, and looking at recognition memory. By testing for recognition, this permitted them to measure participants' phenomenological perceptions of their memory of the recognized words, by asking them to make Remember-Know judgments (Tulving, 1985) to gauge participant's recollection of the words. For all recognized words in the second experiment, participants judged their memory of each item as either *remember* or *know*. A *remember* judgment indicates, "the participant can mentally relive the experience", while *know* judgments mean, "the participant is confident that the item occurred on the list, but is unable to re-experience its occurrence." CNPs that were recognized were often judged as being *remembered*, with participants claiming that they had an actual memory of hearing the word being presented at encoding. *Remember* judgments for CNPs occurred at levels similar to participant's *remember* judgments of items that were actually on the lists (Roediger & McDermott, 1995).

Semantic Processing in the DRM paradigm

The earliest studies on the DRM illusion focused on demonstrating the false memory effect and how easily false memories can be induced and produced. An interest in determining circumstances that might reduce false memories, and in laying out the theoretical bases for the illusion has since moved to the forefront of false memory research (Brainerd, Reyna, & Zember, 2011; Toglia, Neuschatz, & Goodwin, 1999). The role of semantic processing figures prominently in these theories.

Beginning with Craik and Lockhart (1972), hundreds of studies, as literature reviews have shown, have demonstrated the effects that different processing types have on retention. Information processed at “deep” levels is often remembered better than information processed at a “shallow” level (Craik & Lockhart, 1972). Information processed deeply requires a semantic analysis of word meaning, such as rating the word on pleasantness, while shallow processing involves encoding primarily sensory and structural features of the study words.

A number of experiments have addressed levels of processing in the DRM paradigm (Howe & Derbish, 2010; Toglia, Leedy, Baker, & Cheng, 2010; Toglia et al., 1999). While semantic processing typically leads to better memory, studies factoring in false recollection have shown that it also has its limits. Thus, investigators employing the DRM paradigm have found that while semantic processing leads to increased true memory, it also leads to significant increases in the recall and recognition of CNPs. Any task that allows one to access the meaning of items studied increases the likelihood of processing semantic aspects of the items. Doing so not only increases memory for studied items, but also increases the chance for false memory creation (Toglia et al., 1999). These increases are most prevalent when studying word lists blocked together by a central theme, demonstrating the association argument mentioned by

Deese (1959). As memory improvements seen by deep levels of processing are hindered by increased false memory creation, any type of semantic processing that increases memory while limiting the production of false memories would be ideal. Arguments have been made for survival processing to this regard (Nairne et al., 2007).

While the advantage of survival processing demonstrated by Nairne and his colleagues seems to meet these qualifications by showing an increased level of correct recall over other semantic memory tasks, there have been recent failures to replicate these findings (Howe & Derbish, 2010; Toglia et al., 2010). Several current experiments investigating the benefits of survival processing bring into question how far the benefits of survival processing extend. In addition their attempts to replicate Nairne's findings, Toglia and his colleagues (2010) investigated whether DRM lists with survival relevant material were better remembered (recalled) than non-survival lists in an intentional (the participant knows he/she will be tested for retention) memory task. They were specifically interested the interaction between list type and survival processing. One group of participants encoded studied items using the classic grasslands scenario, while another ranked each item on its benefit to survival in general. Overall, survival material was better remembered than non-survival material, however survival-relevant lists led participants to produce somewhat higher levels of false memory. Processing using survival grasslands yielded lower levels of veridical memory than other semantic processing tasks. Additionally, CNPs were recalled at significantly higher rates in the survival grasslands condition than with other semantic memory tasks. Unlike Nairne's work, survival processing did not show any advantage over other deep processing tasks and led to high false memory levels. Interestingly, survival related information was better remembered than non-survival related information, though it too was subject to the same false memory detriment that plagued survival processing (Toglia et al., 2010). While this study used DRM lists and had participants engage in intentional memory, other recent studies more in line with the design of Nairne's original investigation found similar issues with survival processing. Although correct recall and recognition did improve using survival processing, much higher levels of false memory overshadowed any benefits. Such intrusions in memory lowered the overall accuracy of survival processing (Howe & Derbish, 2010). While these and other similar studies' findings do not demonstrate the same benefits Nairne reported, they do not necessarily negate the idea that the human mind is tuned in an adaptive nature, even when taking into account false memories and the limits of human memory performance. In the next section we turn to topics that reflect the fact that memory performance occurs in a social context.

Social Facilitation on Memory Performance

Multiple factors can impact performance on cognitive tasks in addition to those discussed (levels of processing and type of material being studied). Social factors influence memory, with one example being the mere presence of others (Zajonc, 1965). Often, while being observed by others, individuals will perform better on certain tasks than when they are doing them alone, bicycle racing being one example (Triplett, 1898). The presence of others has also been shown to decrease individual's performance on some tasks. Individuals completing a finger maze showed detriments in their performance when others were watching. This was also observed with participants remembering nonsense syllables as they performed worse when remembering in front of others (Zajonc, 1965). However, when participants were brought back several days later the presence of others facilitated recall. Faced with conflicting data, Robert Zajonc proposed that the presence of others was not enough to simply determine whether performance would increase or decrease. He believed the presence of others is a factor that influenced arousal. This experienced arousal in turn affected individual performance, with performance for well-learned responses improving with induced arousal, and performance of new tasks, or ones being learned, being impaired.

Therefore arousal stemming from the presence of others augments dominant responses, while undermining non-dominant responses (Zajonc, 1965). While Zajonc argued that the mere presence of others was enough to influence the performance of dominant responses, follow-up studies found that arousal from mere presence was not sufficient (Cottrell, Wack, Sekerak, & Rittle, 1968). Cottrell and colleagues had participants perform the pronunciation of nonsense words with others simply in the room, showing no interest in the task at hand. Other participants performed while those in the room observed as spectators. Others performed the task alone. Cottrell found that the mere presence of others was insufficient for participants to be influenced by others, and that others must serve as an audience to augment dominant responses and hinder non-dominant behaviors.

Previous studies have shown that similar audience effects can be obtained with the presence of a video camera, which may help and or hinder performance (Constantinou, Ashendorf, & McCaffrey, 2005). Concerned that performance on neuropsychological assessments were hindered by the presence of third party observers, Constantinou and colleagues were interested in the presence of a video recorder would elicit similar behavior. In line with third party presence, the videotaped group’s recall was significantly worse on both immediate and delayed recall. Other studies have expanded this camera effect by demonstrating a benefit to performance, similar to levels seen with active observers; Putz, (1975) demonstrated that arousal from video camera “audience effects” is similar to that of actual observers.

Similar to survival processing and survival relevant material, perhaps the brain has evolved mechanisms to facilitate memory for certain information in high arousal conditions with parallels to survival situations. Information relevant to survival may be better remembered in high arousal situations, as it has evolved to be a dominant behavior. Conversely memory for non-survival relevant information, likely a non-dominant behavior, may be hindered by high arousal situations.

Focus of Current Study

This study was designed to further understand conflicting findings in the survival processing literature, specifically to false memory following the work of Toglia (2010) and Howe (2010), investigating the benefits to survival processing that Nairne has reported. The present experiment addresses survival processing in the DRM paradigm utilizing material from Roediger and McDermott's original lists. Continuing along the lines of Toglia (2010), the current experiment also investigated differences between survival and non-survival material. In addition to survival differences in processing, the present study manipulated participant awareness of performance evaluation, and therefore altering arousal, by video recording some participants' performance in the experiment. As such the hypotheses tested were: survival processing would show no benefits to veridical (true) memory, while yielding higher levels of false memory. Correct recall and false recall for survival lists were expected to be higher than non-survival lists. Also, to the extent that processing survival related information is a dominant response, we hypothesized that the presence of an audience (camera) should facilitate true memory. To the extent that processing non-survival information is a non-dominant response, we further hypothesized the presence of an audience (camera) should interfere with true memory, as well as result in higher levels of false memory.

Method

Participants

A total of 92 undergraduate students from the University of North Florida participated in this study. We enlisted 16 males and 77 females to participate through the use of the online recruiting SONA system. All participants were randomly assigned to one of two camera groups with 46 participants in the camera group and 45 participants in the non-camera group. Participants were also randomly assigned to use one of three different types of processing, with 31 using survival, 28 using pleasantness, and 32 in the control. As is standard with APA ethical guidelines, all participants signed an informed consent. Participants received one hour of extra credit for their participation. Students were offered multiple studies to choose from, and given alternatives to the study for credit in the form of a research paper. One participant's data was excluded due to language barrier issues, as she was unable to understand the requirements of the study.

Materials

Four different lists were selected for use in this experiment. All lists had been developed using the paradigm established by **D**eese (1959) and **R**oediger & **M**cDermott (1995) (DRM lists). As designated by their CPN, the four lists: *chair, needle, smell, and doctor,* were chosen from Roediger's 2001 analysis of such lists (Roediger III, Watson, McDermott, & Gallo, 2001). All four lists were comprised of words centered around a main subject, known as the critical non-presented item (CNP), which was not presented at encoding. The four lists, each consisting of fifteen words, were ranked in order based on their associative strength to the CNP. Words more closely associated with the CNP were at the beginning of the list, with the words at the end of each list less likely to cause the subject to think of the CNP. Lists organized in this manner typically allow the participant to pick up on the central theme of the list more quickly than when organized in reverse order (Roediger III & McDermott, 1995). When participants were exposed to the chair list for example heard: *table, sit, legs, seat, couch, desk, recliner, sofa, wood, cushion, swivel, stool, sitting, rocking, and bench*, with the word *table* more likely to lead to the word chair than the word *bench* would. Refer to *Appendix A* for these four lists.

The purpose of this study was to examine different survival-related aspects and their influence on memory in the DRM paradigm. As such, researchers placed each word list into two different categories. The chair and needle lists were thought to have little to do with survival, while the smell and doctor lists sere seen as more survival related. The Survival lists were balanced against those in the non-survival category as the concreteness of the words in each list, as well as the levels of false recall each list typically produces were held constant across the list conditions. Additionally, the forward associative strength, or the likelihood of the words in an individual list causing the participant to think about the CNP, was also balanced between survival and non-survival lists. All word lists were recorded and edited for audio quality in GarageBand, on an Apple Macbook Pro, and played back for participants using a personal desktop computer in the laboratory using external speakers for clarity. This procedure was chosen to assure no differences would be present during encoding due to fluctuations in tempo, pitch, and dialect from reading to reading between researchers. Four mp3 files were created, each with the lists in a different order. Each file used the same recording of every word list. A tone was used to signify the start and stop of each list. Each list began with a tone, followed by five seconds of silence. Following this, the first list of words would be read at exactly one word every two seconds. A visual metronome was used to assure proper tempo while recording each list. Another tone was played immediately following the reading of the last word in list one.

Ninety seconds of silence were then provided for free recall. At the end of ninety seconds, another tone was played to let the participant know to stop recall. After a ten second break to allow enough time to turn the page in their experimental booklet, another tone was played to signify the start of the next list, which followed five seconds later. This format continued until participants had recalled the last list.

All participants were provided with test booklets that were used both in the processing and recall of each list. The control group did not engage in any type of instructed processing, as they viewed a blank booklet page while listening to the words before recall. The other two groups, pleasantness and survival, were provided sheets on which they rated the words on a five-point scale in order to semantically process the words. The pleasantness group ranked each word on how pleasant they found each word to be, with a rating of 1 being *very unpleasant*, and 5 being *very pleasant.* Those in the survival condition were told to first read the following scenario as it was read aloud to them:

> *In this task we would like you to imagine that you are stranded in the grasslands of a foreign land, without any basic survival materials. Over the next few months, you'll need to find steady supplies of food and water and protect yourself from predators. We are going to show you a list of words, and we would like you to rate how relevant each of these words would be for you in this survival situation. Some of the words may be relevant and others may not, it's up to you to decide*.

This scenario, known as the grasslands scenario, was pioneered by Nairne for use in similar adaptive memory studies, and has subsequently been used in several others (Nairne et al., 2007). In a fashion similar to the pleasantness group, participants immediately heard a word list and ranked each word on its relevance to survival based on the scenario. In this ranking system, 1 was irrelevant to their survival, and 5 was highly relevant to survival. All participants were also provided with a blank, lined sheet of paper for each list, on which to recall the items. A portion of a test booklet is provided in *Appendix B.*

While engaged in both the encoding and recall, half the participants were video recorded as a stressor. The full-size VHS video recorder was placed on a tripod within constant line of sight of the participant. Performance was recorded on four standard 120-minute VHS videotapes.

Design and Procedure

Participants signed up for participation using the University of North Florida's SONA recruitment system online. The study took place in a quiet, controlled lab environment on the third floor of the social sciences building on UNF's campus. The entire experiment took approximately fifteen minutes to complete. Participants had to be run one at a time, regardless of condition. This was done to assure that the influence the camera would have at raising the awareness of social evaluation would be as salient as possible. It was also important for those not in the camera group to feel relaxed and not pressured or judged by anyone who may have been participating simultaneously. Participants were randomly assigned to one of six groups, based on the three different processing types, and the two camera conditions. All participants were presented with every word list, though the order in which they were presented was randomly assigned to each participant.

Upon entering the lab, participant's informed consent and testing booklet were already on the table. All subjects were granted credit before the study began. If in the camera condition, the video recorder was already set up, turned off, and on the tripod. The camera and tripod were kept in their case and out of sight for the duration of the experiment for participants not in the camera condition. After completing the informed consent participants were instructed to turn over their test booklets and mark their gender. They were then told that they would be aurally presented with a four different word lists, and played a sample of the tone that they would hear to signify the starts and stops of the recording. The researcher then explained how the audio file would work. Immediately following each list, they would be given ninety seconds to try and recall as many words as they could, in any order. For a sample of the researcher script see *Appendix C.*

Those in the pleasantness condition were then shown a sample of the 5-point scale they would be using. Participants were then given an explanation of how they were to rank each word on the list based on how pleasant they found it to be. Those in the survival condition followed along reading the grasslands scenario as it was read aloud to them. They then saw a sample of the scale they would use, being told to rank each word on a 1 to 5 scale based on how they thought each study list item heard would help them survive in the scenario they just read.

Participants in the camera condition then were informed that they would be video recorded and that the researchers would watch the videos so their performance could be assessed at a later time. After confirming their understanding, the researcher would then power up the camera, check proper focus and framing, then begin recording. The researcher would then say the participant number aloud, both to match the recording with the testing booklet and to demonstrate to the participant that the camera was recording. After asking the participant if they were ready to begin, the researcher would then instruct the participant to turn to the first page of their booklet, then begin the audio file.

For both camera and non-camera conditions, in the moments prior to the first list playing, the researcher would turn off the computer monitor, so it would not distract the participant. The researcher would then move to the back of the lab, and sit silently for the duration of the memory task, to avoid distracting the participants or risk giving the impression of evaluating their performance. This was designed to assure that the presence of the camera was not overshadowed by the researcher, who stayed present but out of sight for all conditions.

Upon the completion of the last ninety-second recall session, the researcher turned off the camera, if necessary, and collected the test booklet. Participants were then debriefed which included information that the researchers were interested in the connection between social anxiety, processing, and memory. Before leaving they were once again told that all their answers would be kept private.

Results

This study was designed to determine the connections between factors influencing adaptive memory, and free recall performance on DRM lists. The recall memory findings reported below are presented in several subsections, with univariate analyses of variance (ANOVAs) run for all main effects and interactions. Unless noted otherwise, all effects are evaluated at the alpha level of $p < .05$. As each retrieval phase was proceeded by a rating task (survival or pleasantness) at encoding, the first subsection contains a reporting of these rating data.

Ratings at Encoding

A paired samples *t*-test was calculated to compare the mean survival rating of the survival lists and non-survival lists. On a 1-5 scale the mean rating for all survival lists across all participants was 3.23 (SD = 0.64), and the mean rating for all non-survival lists was 2.60 (SD = 0.60). Survival lists were rated significantly higher than non-survival lists on how relevant they would be to helping a participant survive in the grasslands condition (*t*(30) = 7.68, *p* < 0.001.

Figure 1 shows the survival ratings for the two separate list categories.

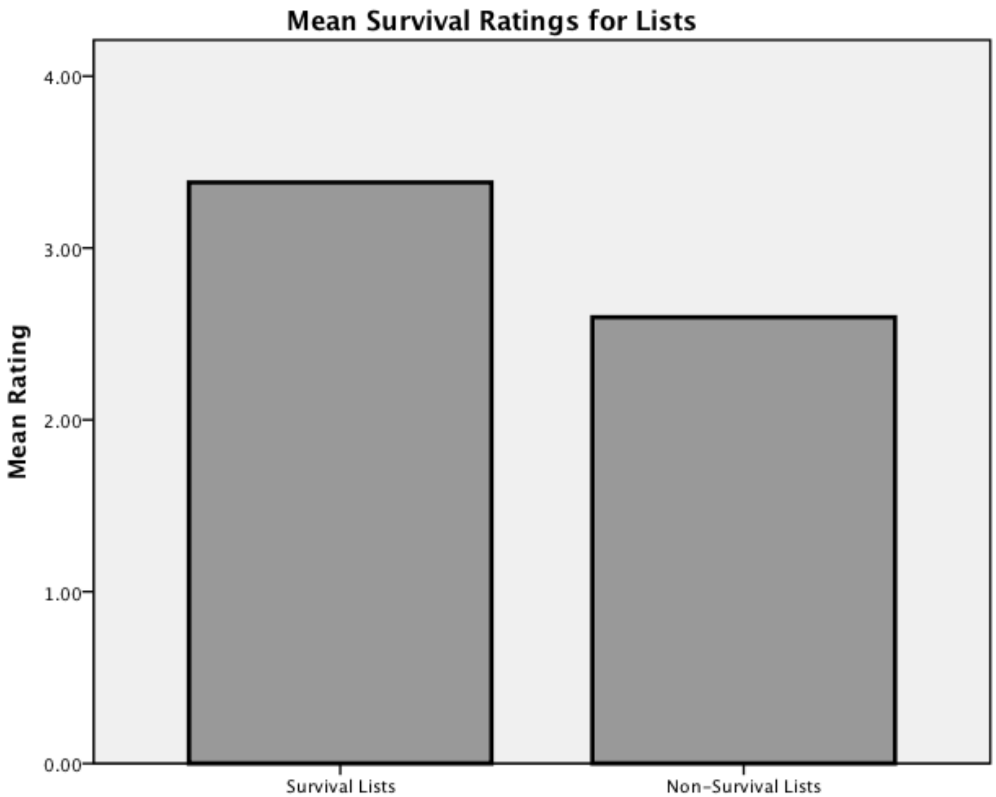

Figure 1. Survival ratings based on type of lists

A paired samples *t*-test was also calculated to compare the mean pleasantness rating of the survival and non-survival lists. The mean pleasantness rating for combined survival lists was 2.98 (*SD* = 0.28), and the mean rating for non-survival lists was 2.76 (*SD* = 0.37). Survival lists were rated significantly higher than non-survival lists on how pleasant participants found them to be (*t*(27) = 3.10, *p* < 0.01). Figure 2 shows the pleasantness ratings for the two separate list categories.

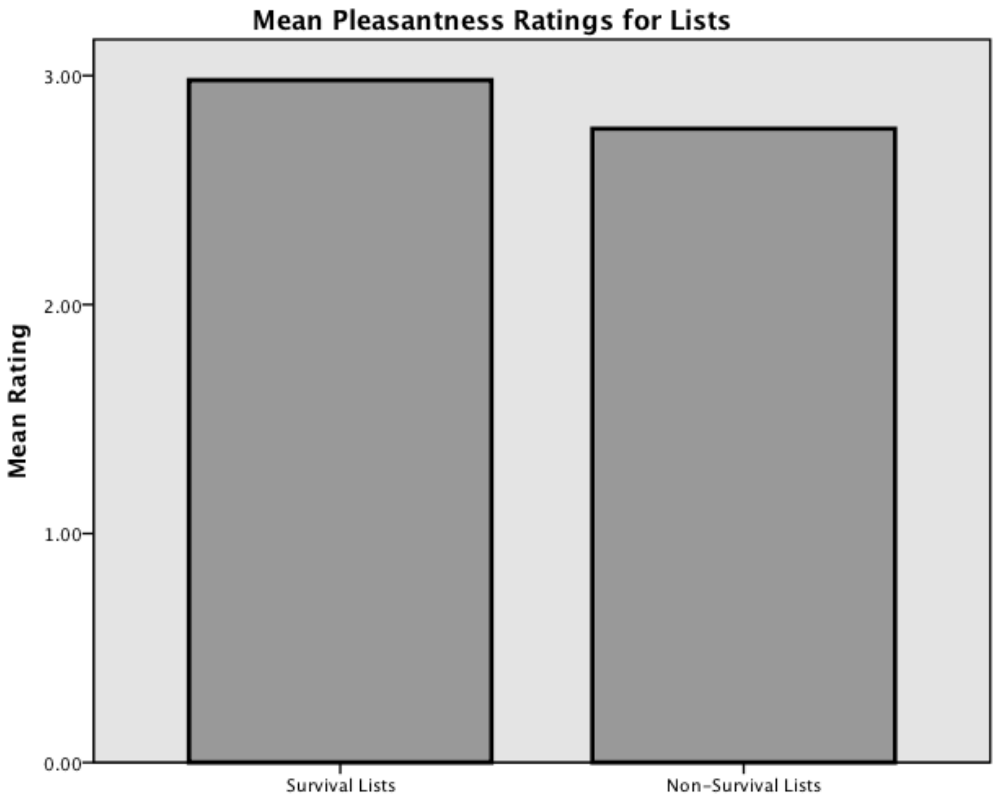

Figure 2. Pleasantness ratings based on type of list

Veridical (True) Memory

A 3 (processing type) x 2 (camera presence) x 2 (list type) mixed design ANOVA, with repeated measures on the last factor, was used to compare participant's levels of correct recall. A significant main effect for processing type was found ($F(2,85) = 4.80$, $p = .011$). Fisher's LSD was used to determine the nature of the differences between processing groups. Participants who engaged in survival processing ($M = 34.84$, $SD = 4.80$) remembered significantly fewer words than both those using pleasantness processing ($M = 37.85$, $SD = 5.31$) and the no-rating control ($M = 38.28$, $SD = 4.28$). Figure 3 shows the correct recall means for the different processing types. No significant main effect was found for list type ($F < 1.00$), with both survival and non-survival lists leading to similar levels of veridical memory. No significant main effect was found for camera condition ($F(1,85) = 1.63$, $p = .205$), indicating that the camera's presence did not influence a participant's level of true memory.

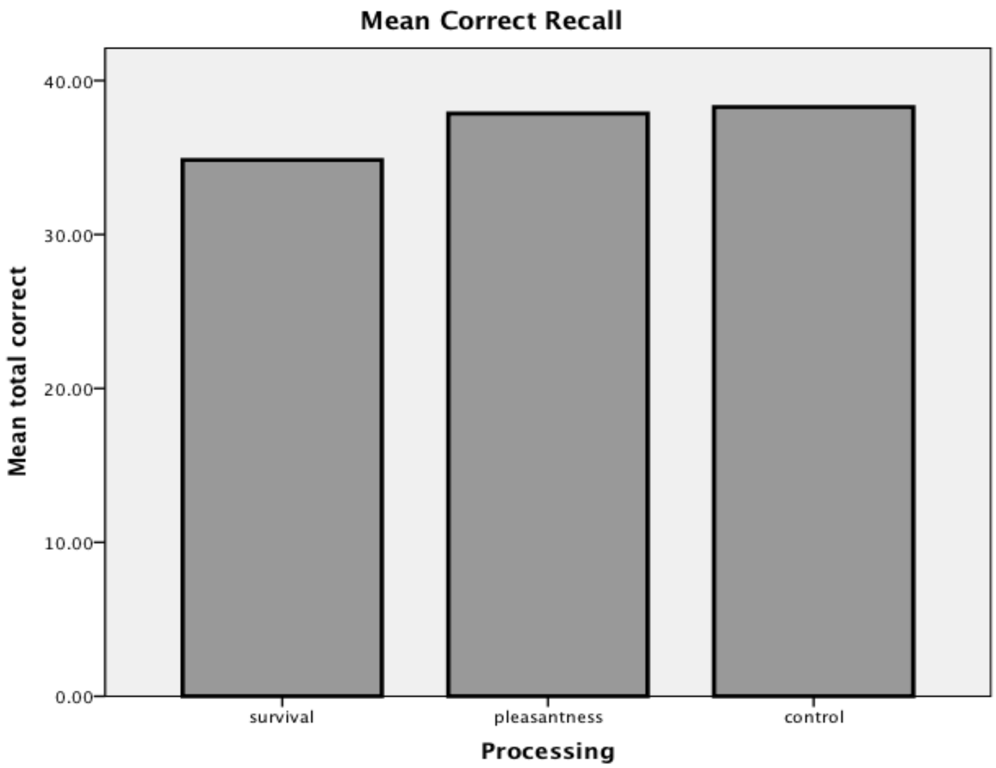

Figure 3. Mean correct recall based on processing type.

The main effects of processing type was qualified by a significant list type x processing type interaction ($F(2,85) = 3.19$, $p = .046$), with non-survival lists leading to higher levels of veridical memory than survival lists, in the control condition. Follow-up tests revealed no other significant differences. This interaction is displayed in Figure 4.

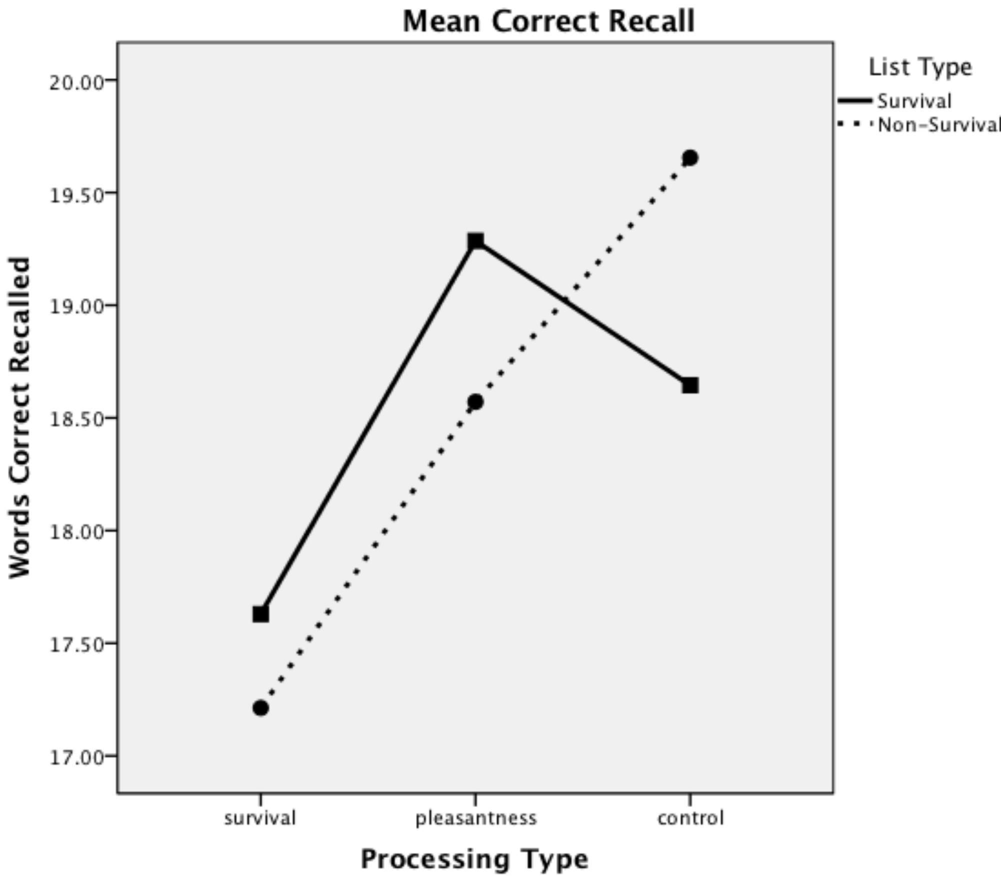

Figure 4. Mean correct recall for processing, separated by list type.

A significant list type x camera presence interaction was also found ($F(1,85) = 6.43$, $p = .013$). Participants in the camera condition remembered significantly fewer words for non-survival lists than those in the non-camera condition. Recall of survival lists was not affected by the camera's presence. All other interactions were found to be not significant ($F(1,85) = 1.15$, $p = .321$). Figure 5 shows the interaction between list type and processing type.

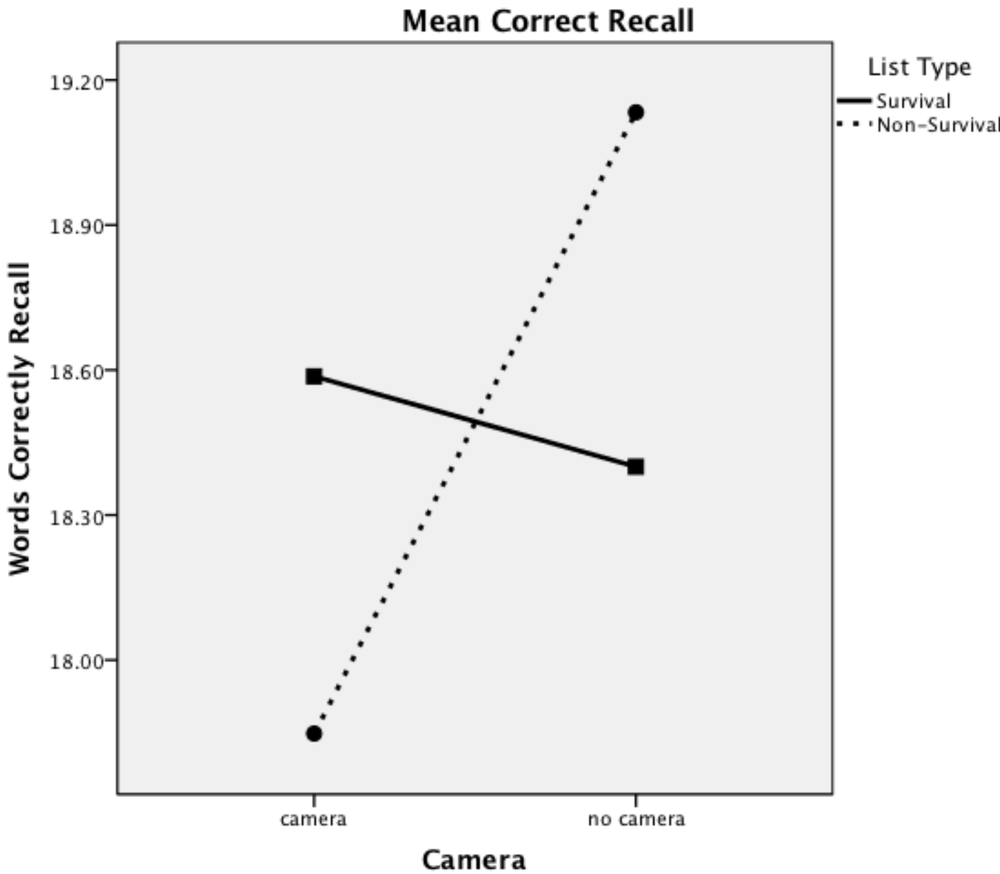

Figure 5. Mean correct recall for camera, separated by list type.

False Memory for Critical Non-Presented Items

A 3 (processing type) x 2 (camera presence) x 2 (list type) mixed design ANOVA, with repeated measures on the last factor, was used to compare participant's recall for CNP's. No significant main effect for processing type was found ($F(2,85) = 1.35$, $p = .265$). A significant main effect was found for list type ($F(1,85) = 10.10$, $p < .01$), with non-survival lists ($M = 1.21$, $SD = .75$) leading to significantly higher levels of false memory than survival lists ($M = .90$, $SD = .85$). This main effect is shown in Figure 6. No significant main effect was found for camera condition ($F(1,85) = 1.60$, $p = .209$), with the camera's presence not influencing a participant's level of false memory for CNP's.

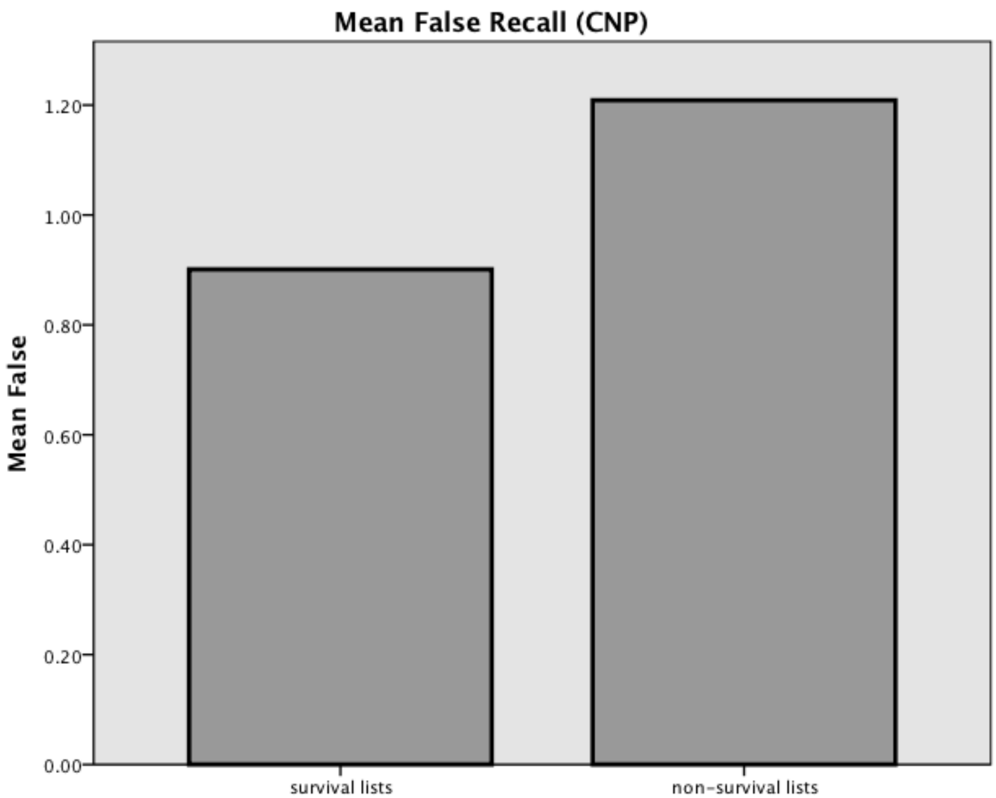

Figure 6. Mean false recall based on list type

The interaction between list type and processing was significant ($F(2,85) = 3.07$, $p = .052$). Further analysis found no significant list type difference for survival processing ($F < 1.00$). When asked to process information in terms of its pleasantness, participants had marginally lower levels of false recall ($t(27) = -1.91$, $p = 0.067$) of non-survival word lists ($M = 1.07$, $SD = .81$) than survival-related word lists ($M = .71$, $SD = .81$). When given no specific guidelines for processing (control), participants had significantly lower levels of false recall ($t(31) = -3.04$, $p < 0.01$) of non-survival word lists ($M = 1.41$, $SD = .71$) than survival-related word lists ($M = .84$, $SD = .85$). This interaction can be seen in Figure 7.

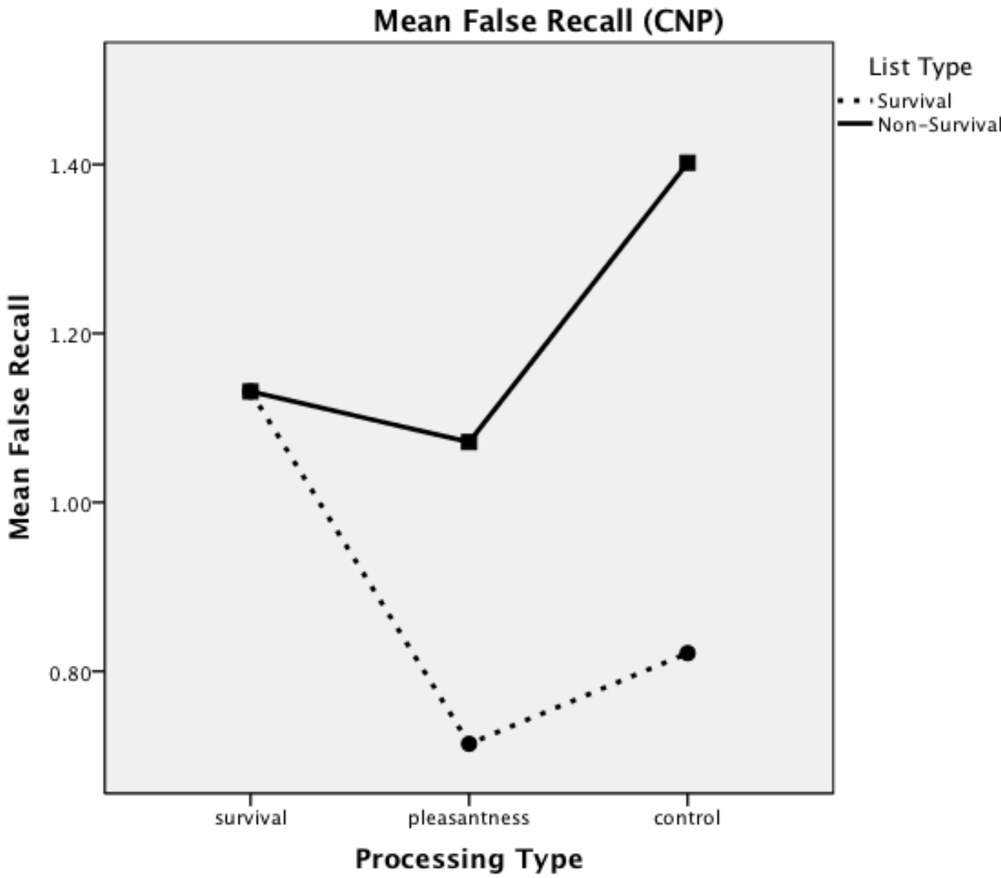

Figure 7. Mean false recall for processing, separated by list type.

Total False Memory

Relying on only CNPs to reflect participant's false memories may underestimate the strength of the false memory illusion. It is well known in DRM studies, that in addition to CNPs, participants frequently recall other thematically-related words that were not presented during encoding. For example, in the doctor list, in addition to recalling this critical item, subjects recalled related intrusions such as "surgery". Thus we calculated a measure called total false memory that reflects all thematically-related intrusions produced by subjects. Total false memory can be as low as 0, with no upper limit for the measure; however the grand mean for total intrusions across all conditions and lists in the experiment was 3.25.

Total false memory = Critical non-presented items + Other related intrusions

A 3 (processing type) x 2 (camera presence) x 2 (list type) mixed design ANOVA, with repeated measures on the last factor, was used to compare participants' levels of total false recall. No significant main effect for processing type was found ($F(2,85) = 1.40$, $p = .252$). List type also showed no significant main effect ($F < 1.00$). Those in the camera condition ($M = 3.74$, $SD = 2.36$) were more likely to recall items not heard during encoding than those in the non-camera condition ($M = 2.76$, $SD = 1.91$), showing a significant main effect for camera presence ($F(1,85) = 4.655$, $p = .034$), as shown in Figure 8.

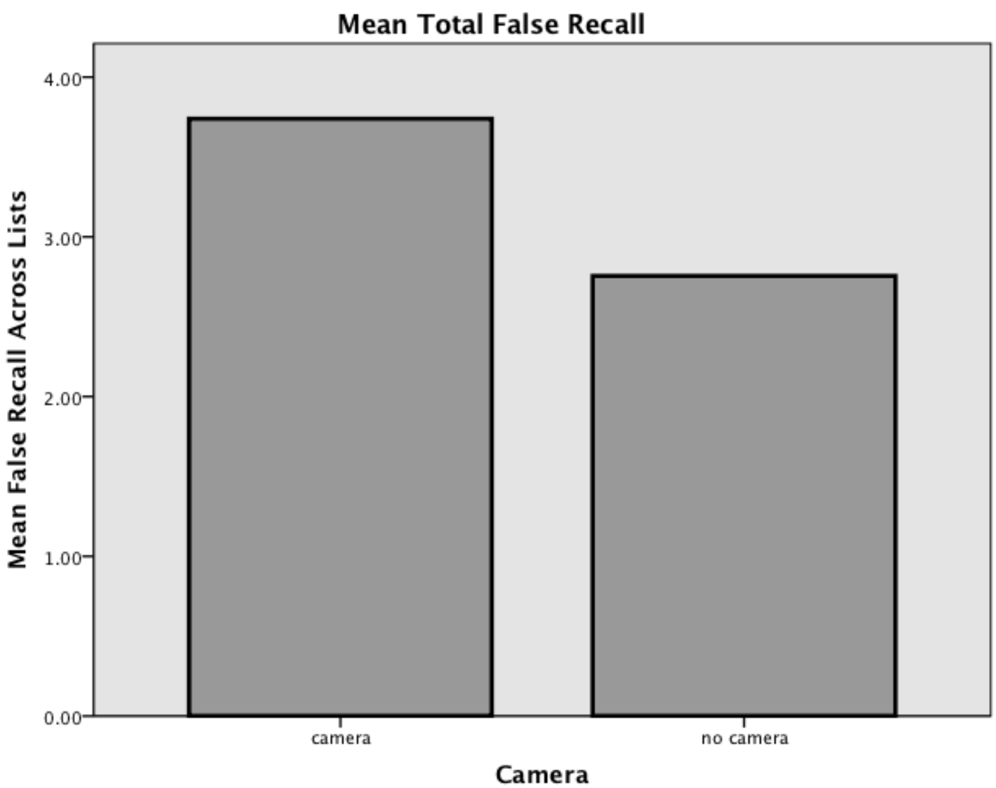

Figure 8. Mean total false recall based on camera presence.

Overall Accuracy

Following the lead of Howe and Derbish (2010), an overall accuracy statistic, ranging from 0.0 to 1.0, was calculated taking both true and false memory into account. Higher scores, closer to 1.0, represent greater accuracy.

$$\text{Accuracy} = \frac{\text{Veridical memory}}{(\text{Veridical memory}+\text{False memory})}$$

A 3 (processing type) x 2 (camera presence) x 2 (list type) mixed design ANOVA, with repeated measures on the last factor, was used to compare participants' levels of overall accuracy. No significant main effect for processing type was found ($F(2,85) = 2.23$, $p = .114$), however the trend was consistent with the true memory findings. There was a significant main effect for list type ($F(1,85) = 10.70$, $p = .002$), with survival lists ($M = .67$, $SD = .27$) having better overall accuracy than non-survival lists ($M = .57$, $SD = .23$). No significant differences were found between camera conditions, however the trend was consistent with the total false memory findings showing detriments to memory performance with the camera present ($F(1,85) = 1.60$, $p = .21$). There were no significant interactions.

Discussion

The current study was designed with three main goals tied to an increased understanding of adaptive memory. First, while many studies have shown that survival processing of word lists is superior to other types of processing, this effect does not seem to extend to methodologies specifically targeting the false memory phenomenon (**D**eese1959; **R**oediger & **M**cDermott1995; DRM paradigm). Second, we were interested in memory for survival relevant and non-relevant information as conveyed by DRM word lists, and their interaction with survival processing. Finally, we were interested in determining if arousal levels generated by social facilitation through the use of a video camera, would influence the DRM illusion. These three goals are addressed below discussing their influence on veridical memory, false memory, and the overall relationship of true to false memory (Toglia et al., 1999).

Processing

While the advantages of survival processing have been demonstrated over many other semantic processing tasks (Kang et al., 2008; Nairne & Pandeirada, 2008; Nairne et al., 2007), questions can still be raised about its global applications. Such findings had led Nairne to state "…survival processing is one of the best – if not the best – encoding procedures yet identified in human memory research, at least when free recall is used as the retention measure" (Nairne et al., 2008, p. 180). Survival processing should be effective to the extent it was an important element at the time when memory modules in humans evolved and were honed over our ancestral history. Thus the environmental factors in the grasslands scenario are the same theorized to be present during the formation of these specific memory modules. That being said, the benefits of survival processing are not only confined to the grasslands scenario, but have been demonstrated using scenarios and predators not possibly present when they evolved (space and zombies) (Soderstrom & Cleary, 2012). While the effectiveness of survival processing is not global in the sense that it is effective in all memory tasks, memory modules that evolved under the exact constraints of ancestral situations are global in that they are still effective when enlisted for processing material under conditions that could not have been present when they evolved (Soderstrom & Cleary, 2012).

While, as reiterated above, survival processing has demonstrated its superiority across different forms of encoding (Kang et al., 2008; Nairne et al., 2007; Weinstein et al., 2008), these benefits have not been replicated in the DRM paradigm (Howe & Derbish, 2010; Toglia et al., 2010). Similar to previous work, we also did not find survival processing benefits for true memory with DRM lists. In fact, grasslands processing yielded significantly lower levels of true memory than both the pleasantness encoding and the control groups.

A majority of the experiments demonstrating survival processing's superiority, including Nairne's initial 2007 study, enlisted incidental memory (a surprise memory task) as opposed to intentional memory (aware of memory task prior to encoding). Many experiments supporting Nairne also employed non-thematic word lists, as opposed to categorically oriented lists. Howe and Derbish (2010) set out to replicate the survival grasslands findings using DRM lists. Staying true to Nairne's original procedure, they randomized DRM lists for presentation, and made the task incidental (Howe & Derbish, 2010). In line with Nairne, Howe's participants in the survival condition had the best recall.

While this demonstrates benefits to survival processing in the DRM paradigm, manipulations not typical of the DRM paradigm were required. Indeed when studied in their traditional form, survival processing led to the lowest levels of recall for processing groups (survival, grasslands, and control), both for the present study and others (Toglia et al., 2010). While we demonstrate limitations to survival processing, the present results do not negate its importance. Survival processing may be less effective for intentional memory, bringing into question it being the "Gold Standard," but this doesn't refute the fact that it is highly effective in certain contexts, and may have evolved to be as such.

This may in fact strengthen the argument that these memory modules evolved under specific ancestral conditions in the environment. Mnemonic situations where survival memory mechanisms excel may mirror the context in which they evolved. As early man most likely did not develop all memory mechanisms while intentionally learning about his surroundings, it makes sense that the benefits found using survival processing do not extend to the intentional memory tasks used here and in Toglia's earlier work (2010). It is doubtful that our ancestors intentionally dedicated most of what they learned to memory. It is more likely that the day-today memories vital to survival were initially encoded incidentally, in survival scenarios, therefore strengthening that specific memory module. Of course, beyond initial encoding, when a particular survival context was re-experienced, intent to remember and elaborating upon a memory module would be in play. While our findings raise questions regarding the ability to generalize survival processing, they support the idea it has evolved into its current state. As a product of evolution, perhaps the human mind is attuned to the retention of survival relevant information.

List Type

We hypothesized that recall for survival relevant lists would be better than for non-survival lists. Though all lists were normed for levels of correct recall (Roediger et al., 2001), in the control group, non-survival lists yielded higher true memory than survival lists. This finding is limited to a subsection of our participants, with no significant differences found among all processing groups. Still, the trend seems to show detriments to correct recall for survival related information. While this seems contrary to other recent findings comparing survival against non-survival material (Howe & Derbish, 2010; Toglia et al., 2010), this pattern did not hold up when analyzing overall memory performance as the high levels of intrusions in all conditions overshadowed any benefits found in the control condition for true memory for non-survival material. In general non-survival lists had a high proclivity for intrusions compared to survival lists, especially in the control group. While this does not align with the “more is less” pattern (Toglia et al., 1999), showing high levels of true memory and high levels of false memory, found by Howe and Derbish (2010) and Toglia et al. (2010), it does support the notion that memory may be tuned to better remember survival relevant information more accurately. This survival benefit is most noticeable in high arousal situations, perhaps similar to those in which they evolved as described next.

Camera

The arousal generated by the presence (or implied presence) of others has been shown to facilitate performance of dominant responses while hindering non-dominant responses (Zajonc, 1965). As our brain mechanisms have evolved over time, survival relevant material ought to have been processed more often, become familiar, and therefore be a dominant response. Non-survival material, on the other hand, may be more novel, less processed, and therefore non-dominant.

If so, then participants performing a recall with a camera present task should perform better in terms of veridical memory for survival related information but worse for veridical memory of non-survival related information. Although not statistically reliable at conventional levels, the presence of a camera did produce means in the expected direction for recall of survival related information. For recall of non-survival related information there were reliable detriments in veridical memory as a function of a camera present during the recall task.

In addition to hindering veridical memory performance for non-survival lists, arousal caused by the camera led to much higher levels of intrusions. Again, social facilitation seems to have a positive effect on dominant responses and a negative effect on non-dominant responses for survival relevant material and situations. Flawless memory is unlikely to be a practiced behavior (intentionally or not), and therefore likely to be a non-dominant response. As such we saw high levels of intrusions in the camera condition compared to the non-camera condition, which are likely caused by poor performance for non-dominant functions. While hindering overall memory performance, the presence of false memories may be beneficial. When assessing the threat of a predator, it may be helpful to miss-categorize an animal not yet experienced.

Limitations

While every attempt was made to assure experimental validity, three limitations arose. First, while we controlled for extraneous influences in the camera condition that other participants may have had on each other by only running one participant at a time, it is important to note that camera saliency may have been hindered by the presence of the researcher in the room. The researcher was out of view of all subjects and had little to no interaction with the participants for the duration of the encoding and recall task, but as classic studies have demonstrated, researcher presence can influence behavior (Milgram, 1963).

Second, while typical DRM studies use several lists, we were limited in the number we could present at study. As we tested participants individually, we were limited in the amount of time we could devote to each participant. To reach a reasonable number of participants we limited the number of lists each participant studied (four, two survival and two non-survival). Both of these concerns address internal validity issues that should be acknowledged in follow-up studies. Furthermore, to heighten external validity, it may be beneficial in future studies to go beyond the use of DRM lists to include other thematic materials such as prose passages, events, and/or pictures.

Finally, as participants were run individually, several months of experimenting yielded only 91 participants. After random assignment to form six different groups, the number of participants in each group was limited to 14-17 participants per group. This limitation raises the specter of whether there was sufficient statistical power in the analyses conducted in the present experiment. Any lack of power would disproportionately influence the detection of higher order interactions.

Future Directions

A majority of the discrepancy between Nairne's work and that of Toglia (2010) and myself may stem from the type of memory task employed (incidental vs. intentional). Follow up studies designed with an intentional memory task similar to that used by Nairne, while still upholding traditional DRM list presentation, would help in understanding the generalizability of the survival processing scenario in promoting very good memory. Additionally the major limitation of this study seems to be the presence of the researcher. A follow up study excluding the researcher would help support the social facilitation findings of this study, and strengthen the idea that memory for survival information is a dominant response. Enlisting measures of psychophysiological evidence (e.g., heart rate and blood pressure) to confirm arousal states of participants would also assure the saliency of arousal inducing mechanisms.

Additionally, pleasantness processing itself may be adaptive. It is clear that certain forms of cognitive processing evolved for sustaining life, though it remains to be seen if certain forms of processing can be identified that evolved because such processing enhanced the quality of life. If so, it is possible that humans developed memory modules to enrich the quality of life, and thus indirectly extended overall survival of the species. Cognitive research could benefit from further studies investigating connections between pleasantness and survival aspects of memory.

Finally, the grasslands scenario was developed with the assumption that our ancestors evolved under similar environmental constraints. Recent fossil findings have led scientists to argue that early man developed in woodlands and not grasslands (Soderstrom & Cleary, 2012). Though others have already demonstrated that the benefits found using the grasslands scenario can also be found in other contexts (i.e. space), it would be interesting to compare findings using a “woodlands” scenario and compare them to current findings.

Conclusions

Overall, Nairne’s claims were not supported, as survival processing saw decreases in true memory, while comparable levels in false memory compared to similar processing types. While the results of the current study question the interpretation of survival processing effects, they lend support, we believe, to the idea of specific evolved memory mechanisms. Human memory seems to have evolved to facilitate human species perpetuation. Memory performance appears to have developed under specific constraints, and while survival processing may not be the “gold standard” of semantic processing, human memory seems to be tuned to these adaptive aspects. This can be seen threefold. First, human memory may perform best when utilizing the same type of memory enlisted while it evolved (incidental). Second, memory for survival relevant material is more accurate than for non-survival material. Third, “high” arousal situations have no influence or positive influence on survival material, while adversely influencing memory for survival irrelevant information. In all, support is shown for the adaptive nature of human memory.

Appendix A

Word Lists

Survival Lists		**Non-Survival Lists**	
Doctor	**Smell**	**Chair**	**Needle**
nurse	nose	table	thread
sick	breathe	sit	pin
lawyer	sniff	legs	eye
medicine	aroma	seat	sewing
health	hear	couch	sharp
hospital	see	desk	point
dentist	nostril	recliner	prick
physician	whiff	sofa	thimble
ill	scent	wood	haystack
patient	reek	cushion	thorn
office	stench	swivel	hurt
stethoscope	fragrance	stool	injection
surgeon	perfume	sitting	syringe
clinic	salts	rocking	cloth
cure	rose	bench	knitting

Appendix B

Sample Test Booklet

Word Memory

Gender______

Please Do Not Open Booklet Until Instructed. Thank You.

Please rate each word as you here it regarding its relevance to the grasslands scenario.

1) 1 ----- 2 ----- 3 ----- 4 ----- 5
Totally Irrelevant to Survival Extremely Relevant to Survival

2) 1 ----- 2 ----- 3 ----- 4 ----- 5
Totally Irrelevant to Survival Extremely Relevant to Survival

3) 1 ----- 2 ----- 3 ----- 4 ----- 5
Totally Irrelevant to Survival Extremely Relevant to Survival

4) 1 ----- 2 ----- 3 ----- 4 ----- 5
Totally Irrelevant to Survival Extremely Relevant to Survival

5) 1 ----- 2 ----- 3 ----- 4 ----- 5
Totally Irrelevant to Survival Extremely Relevant to Survival

6) 1 ----- 2 ----- 3 ----- 4 ----- 5
Totally Irrelevant to Survival Extremely Relevant to Survival

7) 1 ----- 2 ----- 3 ----- 4 ----- 5
Totally Irrelevant to Survival Extremely Relevant to Survival

8) 1 ----- 2 ----- 3 ----- 4 ----- 5
Totally Irrelevant to Survival Extremely Relevant to Survival

9) 1 ----- 2 ----- 3 ----- 4 ----- 5
Totally Irrelevant to Survival Extremely Relevant to Survival

10) 1 ----- 2 ----- 3 ----- 4 ----- 5
Totally Irrelevant to Survival Extremely Relevant to Survival

11) 1 ----- 2 ----- 3 ----- 4 ----- 5
Totally Irrelevant to Survival Extremely Relevant to Survival

12) 1 ----- 2 ----- 3 ----- 4 ----- 5
Totally Irrelevant to Survival Extremely Relevant to Survival

13) 1 ----- 2 ----- 3 ----- 4 ----- 5
Totally Irrelevant to Survival Extremely Relevant to Survival

14) 1 ----- 2 ----- 3 ----- 4 ----- 5
Totally Irrelevant to Survival Extremely Relevant to Survival

15) 1 ----- 2 ----- 3 ----- 4 ----- 5
Totally Irrelevant to Survival Extremely Relevant to Survival

Please recall in any order as many words as you can on the lines provided below.

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Appendix C

Researcher script:

Control:

"You will be hearing a recording of six different lists, each containing several different words read at two second intervals. Upon hearing the last word of each list you will have 90 seconds to try to remember, in any order, as many words as you can. Do you have any questions?"

Survival:

You will be hearing a recording of six different lists, each containing several different words read at a two second interval. "Please read the scenario on the sheet in front of you (hand participant sheet) as I read it aloud. 'Please imagine that you are stranded in the grasslands of a foreign land, without any basic survival materials. Over the next few months, you'll need to find steady supplies of food and water and protect yourself from predators. We would like you to rate how relevant each word would be for you in this survival situation. The scale of relevance ranges from one to five, with one (1) indicating totally irrelevant and five (5) signifying extremely relevant. Some of the words may be relevant and others may not - it's up to you to decide.' As you hear each word please rate it on the scale before you on its relevance to survival. Upon hearing the last word of each list you will have 90 seconds to try to remember, in any order, as many words as you can. Do you have any questions?"

Pleasantness:

You will be hearing a recording of six different lists, each containing several different words read at a two second interval. As you hear each word please rate it on the 1-5 scale before you on its relevance to pleasantness, The scale of relevance ranges from one to five, with one (1) indicating totally irrelevant and five (5) signifying extremely relevant. Upon hearing the last word of each list you will have 90 seconds to try to remember, in any order, as many words as you can. Do you have any questions?"

All (after memory task):

"Thank you for your participation. Please fill out this brief questionnaire. As with the previous form, all responses are confidential."

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Vita

Aaron Leedy was born on . He and was raised by his parents, David and Cheryl Leedy. He attended high school at Mandarin High School in Jacksonville, Florida.

Aaron continued his education at the Florida Community College of Jacksonville and then the University of North Florida where he received a Bachelor of Arts degree in psychology with a minor in deaf studies. He was awarded the Florida Bright Futures Scholarship and several Dean’s List and President’s List honors.

While still an undergraduate student, Aaron conducted research with Dr. Jacob Vigil and eventually the department chair, Dr. Michael Toglia, who became his research mentor. While working with Dr. Toglia on memory research, Aaron served as the lab and project coordinator. After graduating Aaron pursued his Master’s degree in General Psychology at the University of North Florida. During his graduate school career, Aaron’s research has been presented in international conferences nationwide. In addition, Aaron is a member of The Society for Applied Research in Memory and Cognition and Psi Chi. Aaron also served as a teaching assistant and guest lecturer for the Dr. Toglia and several other professors and courses, including Cognitive Psychology, Research Methods, Psychological Testing, Experimental Social Psychology, and Psychobiology. He is currently collaborating with his mentor on a book chapter for an edited volume, and has been nominated for Psychology Graduate Student of the Year.